भारतीय मानक
Indian Standard

IS 17239 : 2019

यात्रियों के आवागमन हेतु रोपवे संस्थापनों के लिए प्रयुक्त ड्राईव की सुरक्षा अपेक्षायें

Safety Requirements for Drives Used for Ropeway Installation for Passenger Transportation

ICS 45.100

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July 2019 **Price Group 3**

Continuous Bulk Conveying, Elevating, Hoisting, Aerial Ropeways and Related Equipment Sectional Committee, MED 06

FOREWORD

This Indian Standard was adopted by the Bureau of Indian Standards, after the draft finalized by the Continuous Bulk Conveying, Elevating, Hoisting, Aerial Ropeways and Related Equipment Sectional Committee, had been approved by the Mechanical Engineering Divisional Council.

An aerial ropeway is a special form of transportation system where passengers/materials are carried on a tensioned wire rope supported above the ground. In ropeways handling passengers, safety, reliability, and conformance to high-quality and good industry practices are paramount for securing the safety of the users. Aerial ropeways are particularly useful in regions where the facility in surmounting natural barriers gives them a great advantage over railways or roads, both of which may need the heavy civil engineering work to secure easy gradient. They are inexpensive to maintain, pollution free, environment friendly, does not affect aesthetics, their power demand is modest and, are not seriously affected by adverse climatic conditions.

Nothing in this standard is intended to contravene any provisions of the statutory regulations wherever they are in force.

Composition of the Panel-1 on 'Aerial Ropeways' of MED 06 responsible for the formulation of this standard is given at Annex B.

For the purpose of deciding whether a particular requirement of this standard is complied with the final value, observed or calculated, expressing the result of a test or analysis shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*). The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

SAFETY REQUIREMENTS FOR DRIVES USED FOR ROPEWAY INSTALLATION FOR PASSENGER TRANSPORTATION

1 SCOPE

1.1 This standard covers the safety requirements for the mechanical and electrical devices of the drive system and other devices for all types of Ropeway installations designed to carry persons.

2 REFERENCES

The standards listed in Annex A contain provisions which, through reference in the text, constitute provisions of this standard. All standards are subject to revision, and parties to make agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards. Annex A gives a list of standards which may be used in the design and construction of aerial ropeways.

3 POTENTIAL HAZARDS

The following events may lead to potential danger or unsafe conditions. They are not necessarily listed in any order or severity as the degree of danger varies in individual circumstances.

a) Failure of any or all of the following units due to improper design/selection/maintenance drive and braking devices;
b) Failure of load transmission at driving sheave resulting in slippage of rope;
c) Obstruction in the movement of the rope;
d) Over speeding; and
e) Failure of the devices to prevent over travel or reversal of rotation.

Necessary safety measures as specified in the standards listed in Annex A shall be taken to avoid such hazards.

4 DRIVE SYSTEMS

4.1 General

4.1.1 Design, operation and maintenance of the system shall conform to the stipulation contained in various ropeway standards listed in Annex A.

4.1.2 The drive system shall be capable of continuous operation under worst loading condition as also suitable for multiple starting and stopping as per system requirement.

4.2 Drive Units

4.2.1 *Drive Motor*

Motors for all applications, such as main, auxiliary, rescue and evacuation, shall conform to the following Indian standards:

IS 13555 : 1999	Guide for selection and application of three-phase a.c. induction motors for different types of driven equipment
IS 12615 : 2018	Line operated three phase a.c. motors (IE CODE) 'Efficiency classes and performance specification' (*third revision*)
IS 900 : 1992	Code of practice for installation and maintenance of induction motors (*second revision*)
IS 1231 : 1974	Dimensions of three-phase foot mounted induction motors (*third revision*)
IS 2223 : 1983	Dimensions of flange mounted a.c. induction motors (*first revision*)
IS 4029 : 2010	Guide for testing three-phase induction motors
IS/IEC60034-5 : 2000	Rotating electrical machines: Part 5 Degrees of protection provided by the integral design of rotating electrical machines (IP CODE) — Classification
IS 8223 : 1999	Dimensions and output ratings for foot-mounted electrical machines with frame numbers 355 to 1 000
IS 8789 : 1996	Values of performance characteristics for three-phase induction motors
IS 12065 : 1987	Permissible limits of noise level for rotating electrical machines

IS 12615 : 2018	Line operated three phase a.c. motors — Efficiency classes and performance specifications (*third revision*)

4.2.2 *Internal Combustion Engine (Diesel Engine)*

Engine shall conform to the following Indian standards:

IS 7451 (Part 1) : 2007	Reciprocating internal combustion engine vocabulary: Part 1 Terms for engine design and operation

4.2.3 *Geared Motor*

Units shall conform to the following Indian standards:

IS 3681 : 1995	Gears — Cylindrical gears — Accuracies (*first revision*)
IS 7504 : 1995	Gears — Cylindrical gears — Accuracies — Method of inspection (*first revision*)

4.2.4 *Gear Unit and Gearboxes — Spur, Worm, Helical*

Units shall conform to the following Indian Standards:

IS 2467 : 2002	International gear notation — Symbols for geometrical data (*first revision*)
IS 3734 : 1983	Dimensions for worm gearing (*first revision*)
IS 4460 (Part 1 to 3) : 1995	Gears — Spur and helical gear — Calculation for load capacity
IS 5037 (Part 1) : 2004/ISO 677 : 1976	Straight bevel gears for general engineering and heavy engineering: Part 1 Basic rack (*first revision*)
IS 5267 : 2002	Vocabulary of gear terms — Definitions related to worm gear geometry (*first revision*)
IS 7403 : 1974	Code of practice for selection of standard worm and helical gear boxes
IS 7443 : 2002	Methods for load rating of worm gear (*first revision*)
IS 7504 : 1995	Gear — Cylindrical gears — Accuracies — Methods of inspection (*first revision*)

4.2.5 *Coupling — Flexible, Universal and Geared*

Units shall conform to the following Indian Standards:

IS 12405 : 1988	Specification for gear type flexible coupling
IS 2693 : 1989	Power transmission — Bush type flexible coupling (*second revision*)
IS 13614 : 1995	Hydraulic fluid power quick action coupling
IS 8805 : 2002	General requirements for ferrule type coupling used in oil hydraulic system (*first revision*)
IS 12405 : 1988	Specification for gear type flexible coupling
IS 12535 (Part 2) : 1991	Automotive vehicles — Transmission systems — Glossary: Part 2 Universal joints and driven shafts
IS 14285 : 1995	Transmission devices — Flexible coupling — Tyre type — Specification

4.2.6 *Bull Wheel*

4.2.6.1 *Design and construction*

a) Bull wheels are made of cast iron, cast steel or fabricated steel. For cast wheel, casting shall conform to the following Indian Standards:

IS 210 : 2009	Grey iron casting (*fifth revision*)
IS 1030 : 1998	Carbon steel castings for general engineering purpose (*fifth revision*)
IS 2856 : 1999	Carbon steel castings for pressure containing parts suitable for fusion welding
IS 13655 : 1993	Guidelines for Heat treatment of cast iron

b) For fabricated wheel, fabrication shall conform to the following Indian Standards:

IS 816 : 1969	Code of practice for use of metal arc welding for general construction in mild steel (*first revision*)
IS 814 : 2011	Covered electrodes for manual metal arc welding of carbon and carbon manganese steel (*sixth revision*)
IS 9595 : 1996	Metal arc welding of carbon and carbon manganese steels — Recommendations (*first revision*)
IS 2062 : 2011	Hot rolled medium and high tensile structural steel (*seven revision*)

c) Wheels shall be stress relieved in accordance with the recommendation contained in the standards listed in (a) and (b) above.
d) Wheels shall be lined with suitable material having grooves for proper placement of the rope.
e) Wheel flanges shall be such shaped so as to prevent deropement.
f) The diameter of the driving or return sheaves shall be not less than 80 times that of the wire rope and 800 times that of the outer wires of the wire rope.
g) Other recommendation as contained in ropeway standards listed in Annex A.

4.2.6.2 *Testing*

Before putting to service, wheels shall be subject to following tests to ensure conformance to its design:

a) Physical and chemical properties of material;
b) Hardness;
c) Radiographic / ultrasonic; and
d) Magnetic particle.

4.2.7 *Shafts*

4.2.7.1 *Design and construction*

a) Shafts shall be designed for the most unfavourable load condition and simultaneously occurring reversal of loads;
b) Shall have a minimum factor of safety of 5.0 measured as a ratio of ultimate stress of material and calculated resultant stress; and
c) Conformance to the following Indian Standards:

IS 3688 : 1990	Power transmission-shafts — Dimensions for cylindrical and 1/10 conical shaft ends (*second revision*)
IS 919 (Part 1) : 2014/ ISO 286-1 : 2010	Geometrical Product Specifications (GPS) — ISO Code System for Tolerances on Linear Sizes: Part 1 Basis of Tolerance, Deviation and Fits (*third Revision*)
IS 2048 : 1983	Specification for parallel keys and keyways (*Second Revision*)
IS 2292 : 1974	Specification for taper keys and keyways (*first revision*)

4.2.7.2 *Testing*

Recommendation contained in **4.2.6.2** shall apply. In addition fatigue test shall be carried out in accordance with the following Indian Standards:

IS 5074 : 1969	Method for axial load fatigue testing of steel
IS 12514 : 1988	Method for torsional stress fatigue testing

4.2.8 *Brakes*

4.2.8.1 *Design and construction*

a) General requirement and performance parameters of Brakes provided in ropeway standards listed in Annex A;
b) The braking force shall be produced by weights or by releasing pre-loaded compression springs;
c) The braking force produced by the Brakes shall be adjustable to the current load conditions, if it causes discomfort to the passengers or any material damage;
d) It shall have provision to adjust for any wear on the brake linings; and
e) The braking surfaces of sheaves, discs and drums shall be machined to an accuracy appropriate to the required clearances for brake pad / lining as specified by the manufacturer.

4.2.9 *Electrical Control and Monitoring Units*

4.2.9.1 *Design and construction*

a) Each ropeway shall have a control console regardless of the type of control system;
b) If a safety function is initiated or an emergency stop device is operated or in case of power failure, the cableway shall automatically be brought to a stop and brakes are ‘ON’; and
c) Conformance to the following Indian Standards:

IS 10118 (Part 1) : 2018	Code of practice for Selection, Installation and Maintenance of Switchgear and controlgear: Part 1 General (*first revision)*
IS 9926 : 1981	Specification for Fuse wires used in rewirable type electric fuses upto 650 volts
IS 3914 : 1967	Code of practice for selection of a.c.motor starts (voltage not exceeding 1 000 volts)
IS/IEC 60947-4-1 : 2012	Low-voltage switchgear and controlgear: Part 4 Contactors and motor-starters, Section 1 Electromechanical contactors and Motors-Starters
IS/IEC 60947-1 : 2007	Low-voltage switchgear and controlgear: Part 1 General rules
IS 1646 : 2015	Fire safety of buildings (general) code of practice electrical installation (*third revision*)

IS 14254 (Part 2) : 2006/ IEC 61131-2 : 2003	Programmable controller: Part 2 General information (*first revision*)
IS 3043 : 2018	Code of practice for earthing (*second revision*)
IS 2026 : 2011	Power transformer
IS 8528 : 1988 & 10 000	Pliers, anterior band forming, double beak, dental (*first revision*)
IS 13364 : 1992	Alternator
IS 8143 : 1976	Plugs and keys for resistance boxes

ANNEX A

[*Clauses* 2, 3, 4.1.1, 4.2.6.1(g), and 4.2.8.1(a)]

LIST OF INDIAN STANDARDS RELATED TO AERIAL ROPEWAY

IS No.	*Title*
7649 : 1975	Glossary of terms used in connection with aerial ropeways and cableways (*under revision*)
5228 : 2017	Continuous movement monocable ropeways with fixed grips — Code of practice (*second revision*)
5229 : 2017	Continuous movement monocable ropeways with automatic grip — Code of practice (*second revision*)
5230 : 2017	To and fro (jig back) movement bi-cable ropeways — Code of practice (*second revision*)
16620 : 2017	Jig back movement monocable ropeways with fixed grips — Code of practice
16623 : 2017	Pulsated movement monocable ropeways with fixed grips — Code of practice
9706 : 1997	Aerial ropeways for transport of material — Construction and design — Code of practice (*under revision*)
9228 : 1979	Specification for mono seat chairs for chairlifts used in winter Sports (*under revision*)
9595 : 1996	Metal arc welding of carbon and carbon manganese steels Recommendations
IS/ISO 9001 : 2015	Quality management systems — Requirements (*fourth revision*)

ANNEX B

(*Foreword*)

COMMITTEE COMPOSITION

Composition of the Panel-1 on 'Aerial Ropeways' MED 06

Organizations	*Representative(s)*
In Personal Capacity	SHRI A. BHADRA (***Convener***)
In Personal Capacity	SHRI C. K. KARMAKAR
In Personal Capacity, Kolkata	SHRI DWIJENDRA LAL DAS (*Invitee*)
CSIR-CIMFR, Dhanbad	DR DEBASISH BASAK
CRS, Pvt Ltd, Kolkata	SHRI K. BOSE
Damodar Ropeways & Infra Ltd, Kolkata	SHRI RANJAN MUKHERJEE
Usha Breco Limited, Ghaziabad	SHRI MANOJ PANWAR

Member Secretary

SHRI A. K. MOHINDROO
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Bureau of Indian Standards

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This Indian Standard has been developed from Doc No.: MED 06 (13874).

Amendments Issued Since Publication

Amend No.	Date of Issue	Text Affected

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Published by BIS, New Delhi